CHAPTER 18

RADIOACTIVE WASTE MANAGEMENT IN POLAND: CURRENT STATUS OF INVESTIGATIONS FOR RADIOACTIVE WASTE REPOSITORY AREAS

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Abstract: General information about the regulations and limitations concerning radioactive waste in Poland is given in the paper. Radwaste, 95% of which is low level at present, comes from one research reactor and over 2000 smaller producers. The responsibility for collecting, handling and disposal of all radwaste is delegated to one organization partially supported by the state. The status of new repository site investigations is reviewed.

18.1 INTRODUCTION

The suitable management of radioactive waste and spent fuel from research reactors appears to be one of the most important problems in Poland, because it has an impact on the safety and public acceptance of nuclear energy and the further development of this technology.

It is estimated that ionizing radiation sources in this country with an activity of about 200,000 Ci are being used in medicine, industry and scientific research activities. As of January 1, 1993, spent fuel from research reactors with an activity of 800,000 Ci (including 6000 Ci from transuranic elements) were in storage at the Institute of Atomic Energy (IEA) at Swierk. Decommissioning of research reactors is also a very important problem that should be taken into account in waste management programs.

18.2 LEGISLATION FOR RADIOACTIVE WASTE MANAGEMENT

Radioactive waste management in Poland is regulated within the framework of:

1. The Atomic Law, laid down April 10, 1986, by an Act of Parliament, in which the utilization of atomic energy for the public, as well as the economic needs of the country, is defined; and
2. A regulation from the President of the National Atomic Energy Agency (NAEA), announced May 19, 1989, on the Principles of Defining Waste as Radioactive, Classifying Them and Keeping Records, and the Immobilization, Storage and Disposal of Wastes.

To ensure safe transport of radioactive material, the IAEA regulations (Safety Series No. 6, 1985), and modal ADR, RID, IATA and IMO regulations are applied as appropriate. In practice, the transport of radioactive waste is only by road.

Radioactive waste is separated as follows: (1) beta and gamma emitters - high level (HLW); (2) alpha emitters; and (3) spent sealed radioactive sources. According to the regulation mentioned above from the NAEA's President, waste classifications are based on ALI principles as shown in Table 18.1.

18.3 SOURCES OF RADIOACTIVE WASTE IN POLAND

In Poland, radioactive waste comes from research reactors, scientific and educational institutions, industrial organizations and hospitals. Only low and intermediate level wastes are produced. The high activity gamma emitters in spent sources should be transported back to the supplier, but a number of them are still stored at different places in the country.

For many years, Poland has operated two research reactors and one critical assembly; and at present, a few thousand spent fuel elements from these reactors are stored at the site of the Institute of Atomic Energy. The storage facilities were originally planned only as tempo-

Table 18.1. Waste classifications.

Waste Form	Radiation	LLW	ILW	HLW
Solid	beta, gamma (ALI/m^3)	10^2-10^6	10^6-10^9	$>10^9$
	alpha (ALI/m^3)	$>10^2$	-	-
Liquid	beta, gamma (ALI/m^3)	10^{-2}-10^2	10^2-10^5	$>10^5$
	alpha (ALI/m^3)	$>10^{-2}$	-	-
Gaseous	beta, gamma (DAC)	0.1-10	10-10^6	$>10^6$
	alpha	>0.1	-	-

Note: **ALI** denotes a derived factor being the annual limitof radioactive intake through the alimentary canal (ALIp) or respiratory system (ALIo) for people employed in conditions of radiation exposure, stated in separate provisions.
DAC denotes a derived factor being the concentrations of radionuclides in the atmosphere for people employed in conditions of ionizing radiation, stated in separate provisions. DAC = ALIo/2400 m^3 where value of 0.1 DAC corresponds to the ventilation outlet.
In the case of unidentified isotopes, a more restrictive limit expressed in Bq/kg or Bq/m^3 may be used.

rary storage on the assumption that the spent fuel would be taken back by the Soviet supplier. The spent fuel is kept in a wet storage facility close to the reactor, and the age of the oldest irradiated fuel elements is 35 years. Conditions at the storage facilities are controlled by the user and by the National Inspectorate for Radiation and Nuclear Safety. The question of how and where this spent fuel is to be transported, stored or reprocessed appears to be one of the most important questions to be considered by the Government. Establishing a clear policy regarding the management of spent fuel seems to be one of the major elements having an impact on public acceptance of nuclear energy.

18.4 Organizations Responsible for Waste Management and Scope of Their Duties

According to the above mentioned Atomic Law:

- The issues falling within the scope of the Agency's activity is radioactive management;
- The head of the organizational unit within which the radioactive wastes arise is responsible for their handling in full conformance with the nuclear safety and radiation protection requirements and their preparation for transport and storage; and
- The head of the organizational unit that has been licensed to operate a radioactive waste disposal facility is responsible for keeping the radioactive waste in full conformance with the nuclear safety and radiation protection requirements.

The President of the National Atomic Energy Agency is designated, and can be recalled, by the Prime Minister and reports directly to him. The Management Committee, under the supervision of the President, acts within the Agency. The Committee adopts resolutions on matters related to the scope of the Agency's activities.

The responsibility for LLW/ILW over the entire country is delegated to the Institute of Atomic Energy. At present, practically all radwastes are collected, treated and conditioned at the IEA and disposed of at the Central Repository (CR) located at Rozan.

18.5 Treatment and Conditioning of LLW/ILW

The radioactive waste treatment and the conditioning methods at the IAE are aimed at reducing volumes and preparing for safe transportation and storage to fulfill the requirements for final disposal at the CR.

Low level liquid waste is chemically treated in a clarifier resulting in a volume reduction of about 100 times, and the sludge is transferred to a bitumization plant for further treatment. On the other hand, ILW is concentrated by evaporation, and the distillate is further purified by ion exchange before being released. The concentrates (evaporator sludge) are conditioned by cementation, and the radioactivity and chemistry of the decontaminated liquid effluents are controlled before being released. Solid LLW is compacted into 0.2 m^3 drums using a 12-ton press, and the biological wastes, after urea-formaldehyde conditioning, are stored in 0.05 m^3 drums.

18.6 STORAGE OF RADIOACTIVE WASTE

The Central Repository for radioactive waste is a near-surface type located 90 km from Warsaw on the grounds of a former military fort built in 1905. The CR was put in operation in 1961. The geology of the site is characterized by boulder and sandy clay. No historical records regarding seismic activities in the area are available.

Most of the repository is characterized by a concrete structure of military design with roof and wall thicknesses of 1.2 to 1.5 m, and a floor thickness of about 30 cm. Within a protection trench of the fort, a moat is used for final disposal with a concrete cover about 20 cm thick. Only solid and solidified low and intermediate level wastes are stored at the CR. After 33 years of operation, about 5400 m^3 of wastes have been disposed of in this repository. The cumulative activity of these wastes is 250,000 GBq (without decay), or 40,000 GBq with decay.

18.6.1 Storage in Concrete Bunkers

Concrete bunkers are used for temporary storage of alpha waste and contaminated installations and devices, which will be reused. Solid alpha wastes are placed in a chamber that is sealed off, after being filled, with a brick wall. Sealed sources of waste, with activities that do not exceed 4 GBq, are disposed of in one of the underground concrete bunkers. The access hole to this bunker is sealed with a lead cover lid 200 mm in thickness.

Except for the alpha waste categories, the LLW is disposed of in the moat of the CR where the bed and walls are made of concrete. The containers of the conditioned waste are placed in layers that are separated by layers of concrete. This procedure is repeated until the moat is filled to capacity, and the top layer is protected by asphalt.

18.6.2 Environmental Radiation Monitoring

The on- and off-site radiation monitoring system at the CR includes two basic groups of measurements:

- Radioactivity levels in environmental samples, and
- On-site and off-site gamma radiation levels.

Records of measurements are made by the IAE and presented annually to the National Inspectorate for Radiation and Nuclear Safety as well as to the appropriate local administration.

18.7 NEW REPOSITORY SITE INVESTIGATIONS

A study was initiated in Poland in the late seventies aimed at selecting areas suitable for radioactive waste repositories. Initially, the main attention was concentrated on selecting areas characterized by rock systems suitable for the permanent isolation of wastes. Salt beds, crystalline rocks and clay formations of considerable thickness were considered the most appropriate rocks for an underground repository.

The study was conducted upon the request, and was coordinated, by the National Atomic Energy Agency. Many specialists from various scientific institutions participated in the elaboration of specific issues. The investigations were designed to determine potentially useful repository sites in three categories: (1) superficial; (2) shallow underground; and (3) deep underground (see Nos. 1-10, Fig. 18.1).

18.7.1 Deep Underground Waste Repositories

An examination of geological formations that initially appeared suitable for the construction of deep waste repositories and could satisfy nuclear safety requirements led to the following selection of sites shown on Figure 18.1:

- Silurian shales in northern Poland (No. 5);
- Granites, bastard granites, crystalline Pre-Cambrian shales in eastern Poland (No. 6); and
- Triassic mudstone (No. 4).

The location of a repository within these formations

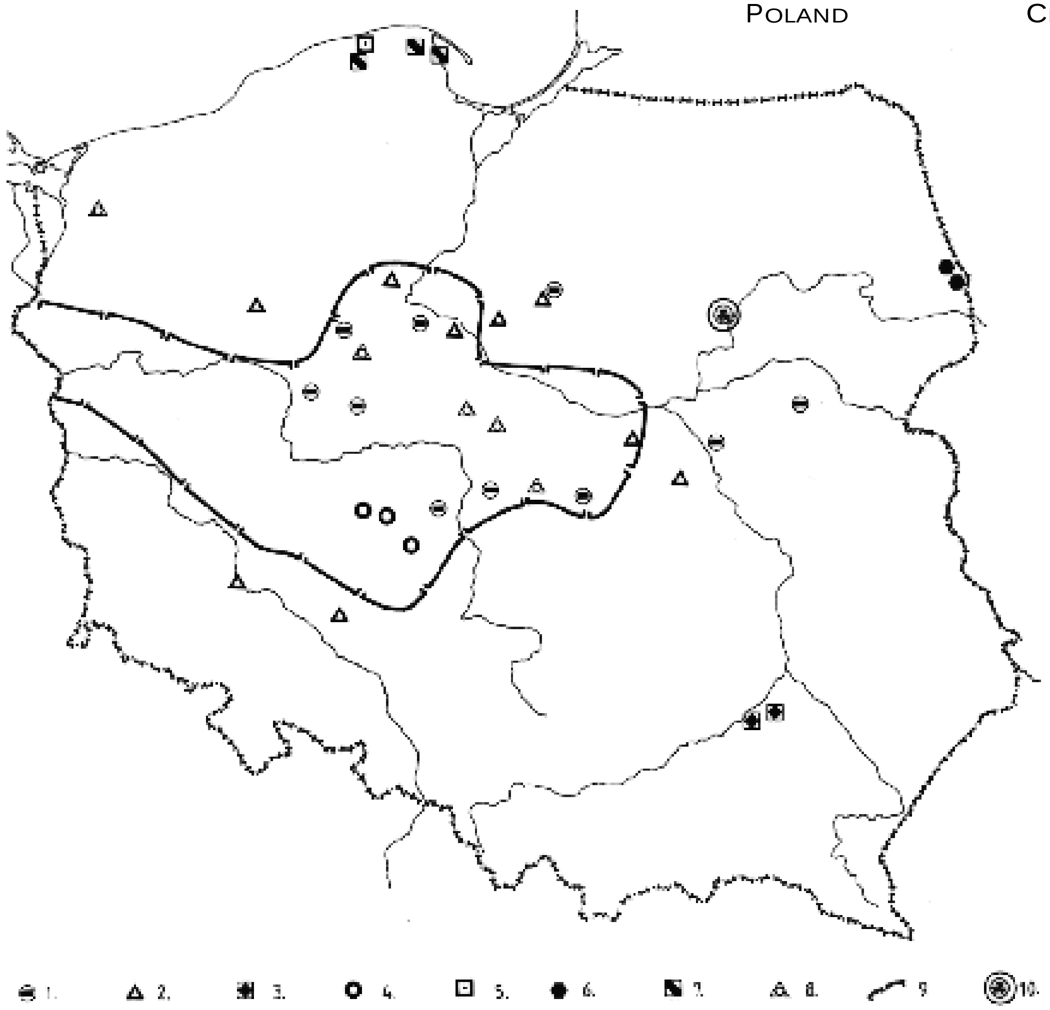

Figure 18.1. Areas selected in Poland for the possible location of a radioactive waste repository: 1 - superficial (Quaternary); 2 - shallow underground (Tertiary-Pliocene; 3 - shallow underground (Tertiary-Sarmatian); 4 - deep underground (Triassic)’ 5 - deep underground (Silurian); 6 - deep underground (Pre-Cambrian); 7 - deep underground (Permian); 8 - deep underground(Permian); 9 - limits of area with favorable climatic conditions for superficial radioactive waste repositories; and 10 - active repository at Rozan.

would require the construction of deep underground works.

In discussions concerning waste storage in other rock types, the concept of storage in salt formations was also considered. The following selections were made from an analysis of formations of Permian and Miocene age:

- Rock salt in the Baltic region (No. 7); and
- Salt diapirs in central Poland (No. 8).

Information on rock salt has been revealed in varying degrees by wells and geophysical investigations. These earlier studies were conducted in terms of assessing the salt resources for the chemical industry. Solution mining (lixiviation) of storage cells in one of the rock-salt diapirs was considered to be the most appropriate solution.

During the period of planning for the development of nuclear energy, a study was carried out to determine the best waste repository policy to adopt concerning rock-salt beds in northern Poland. A method was presented for the prognosis of thermal effects in an underground repository for highly radioactive waste and the problems of optimizing the underground works and the storage technique. The repository was assumed to be located in Permian salt beds at a depth of 740 m beneath the surface. The average bed thickness in the area of the repository is about 200 m, and the overlying formations are anhydrides and Permian dolomite limestones. Above these beds are Mesozoic and Cenozoic formations with possible water-bearing strata.

To develop the prognosis of the temperature distribution, a method was proposed that is based on an analytical solution to the thermal conduction equation for the individual source (waste container). With regard to the design stages of the repository, this method allows one to more rapidly assess an optimal scheme for the distribution of repositories. The results of this model study showed that the thermal impact of such a repository becomes apparent only after some one hundred years and that the impact is practically negligible.

18.7.2 Shallow Underground Waste Repositories

Further considerations were therefore limited to the construction of a shallow repository in clay formations. The radioactive waste would be stored in shallow pits or large-diameter wells some 50-70 m under the surface. The following formations were selected:

- Krakowiec clays (Tertiary period - Sarmatian) in southeast Poland (No. 3); and
- Spotted clays (Tertiary-Pliocene) in central Poland (No. 2).

An analysis of the population conditions and physical management was carried out at these sites.

18.7.3 Superficial Waste Repositories

The existence of outwash sands that are located in boulder clays were selected as a favorable location for superficial waste repositories. The most favorable location on the watersheds of rivers is also essential. A study was carried out at ten locations using the methodology recommended by the International Atomic Energy Agency for the pre-selection and selection stages. The prospective areas were separated from major regions for further detailed analysis. An evaluation of the usefulness of the areas selected was carried out, in relation to an analysis of geographic conditions, on the basis of the existence of conditions that would exclude or limit the area itself. The characteristics of the areas were analyzed in terms of the following issues:

- Geological setting and hydrogeological conditions;
- Geodynamical processes;
- Potential of raw materials;
- Hydrology;
- Meterology and climate; and
- Environmental management and protection.

Most locations were concentrated in central Poland (No. 1 on Fig. 18.1) within an area where favorable climatic conditions for a superficial repository prevail. The following conditions were considered to be preclusive factors:

- Presence of legally protected areas (reservations, national and landscape parks);
- Areas with planned regional limitations on physical management;
- Areas under the influence of a concentrated groundwater exploitation;
- Areas with imminent 100- and 500-year floods;
- Areas where the subsurface waters are highly mineralized; and
- Areas with shallow groundwater.

An analysis of the social and economic conditions were also carried out in some of the locations. At the same time, attempts were made to obtain social acceptance for locations selected for a superficial repository.

18.8 SUMMARY

The nuclear energy development program in Poland is still not precisely defined, but it is clear that any further advancement in the field of nuclear technology cannot be pursued without solving the waste isolation problem. For the future of the national economy, there is a need for serious consideration of this source of energy. An increase in environmental protection studies is now quite evident and results in an enforced continuation of previous research concerning the the location and documentation of new repository sites.

The results presented in this paper are concerned primarily with the preselection stage. Only in the case of superficial radioactive waste repositories are some elements of the selection stage being investigated. Within a period of about ten years, the next studies will concentrate on the choice of possible locations for underground and superficial radioactive waste repositories. It is evident that, after potential sites have been selected, quite different programs of time-consuming research will be required for each of these types of repositories.